

VALIDATION OF CRYOSAT-2 SEA ICE FREEBOARD RETRIEVALS BY GROUND AND AIRBORNE SURVEYS

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Sea Ice in the Polar Climate System

2007 Summer Minimum Extent: 4.28 km²



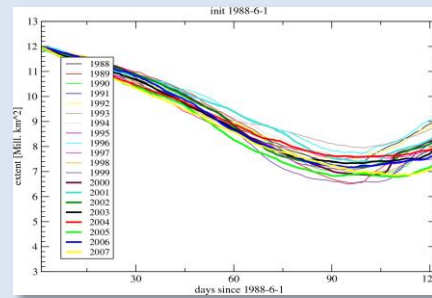
Impact of Sea Ice Thickness:

Model forecast of summer minimum extent based on

- ensemble of atmospheric forcings: 1988 – 2007
- initial ice conditions on June 1

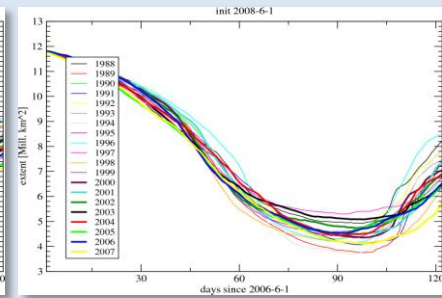
June 1, 1988

Predicted Minima: 7.18 km²



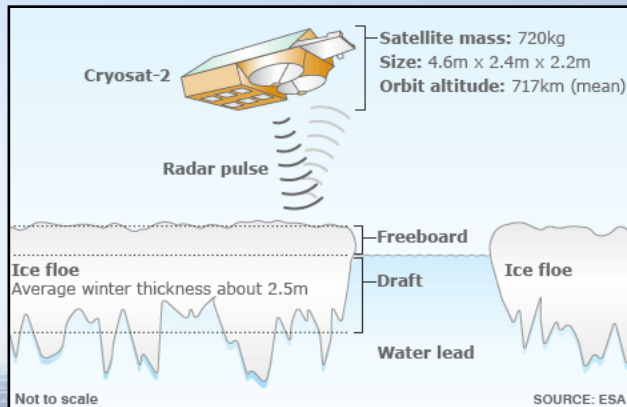
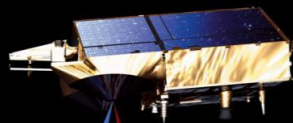
June 1, 2008

Predicted Minima: 4.22 km²



Difference only driven by initial ice thickness!

Sea Ice Thickness Retrieval with CryoSat-2

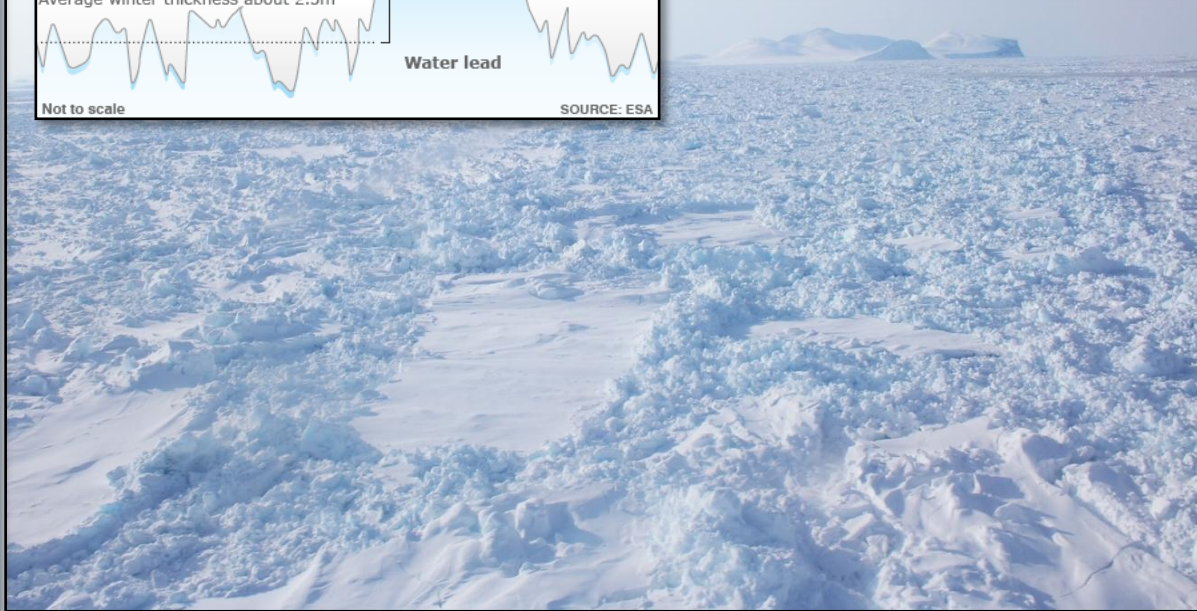


Limiting Factors

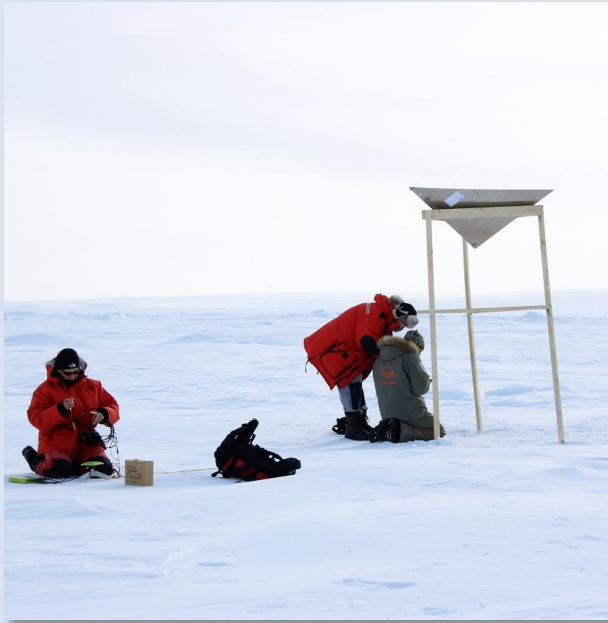
Radar Penetration into Snow

Surface Roughness

Surface Variability



CryoSat Validation Experiment (CryoVEx)



Validation Concept

In-situ field work

- high resolution snow & ice information
- local scale

Airborne Surveys

- statistics of different ice types
- regional scale

In-situ

- Sea ice thickness
- Snow stratigraphy
- Ground radar

Airborne

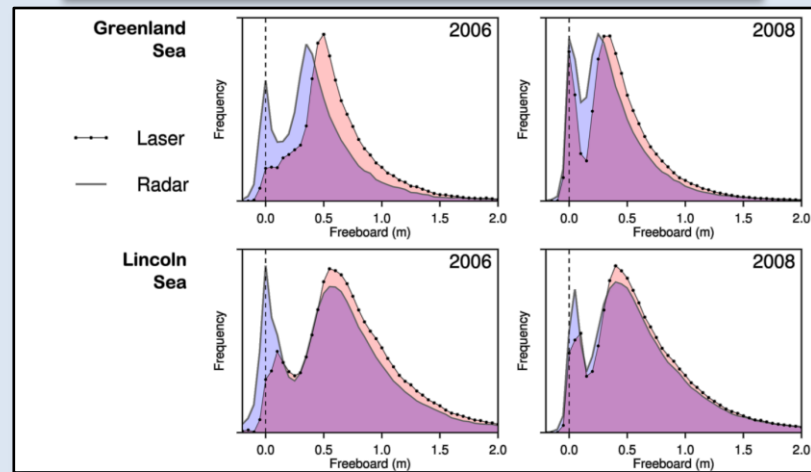
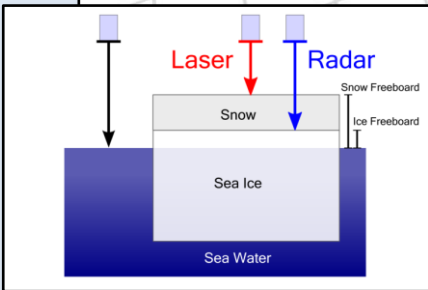
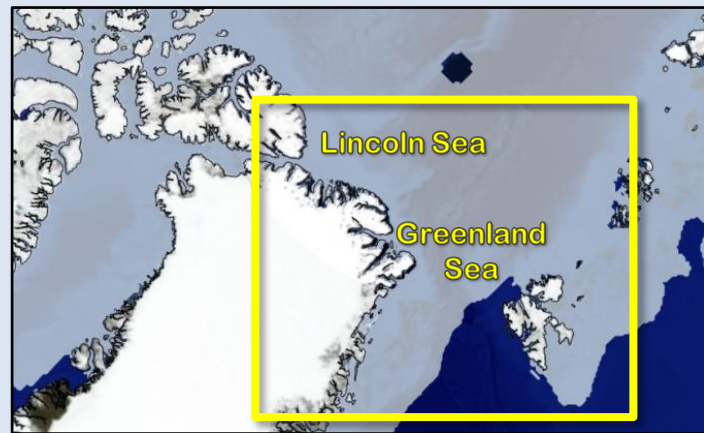
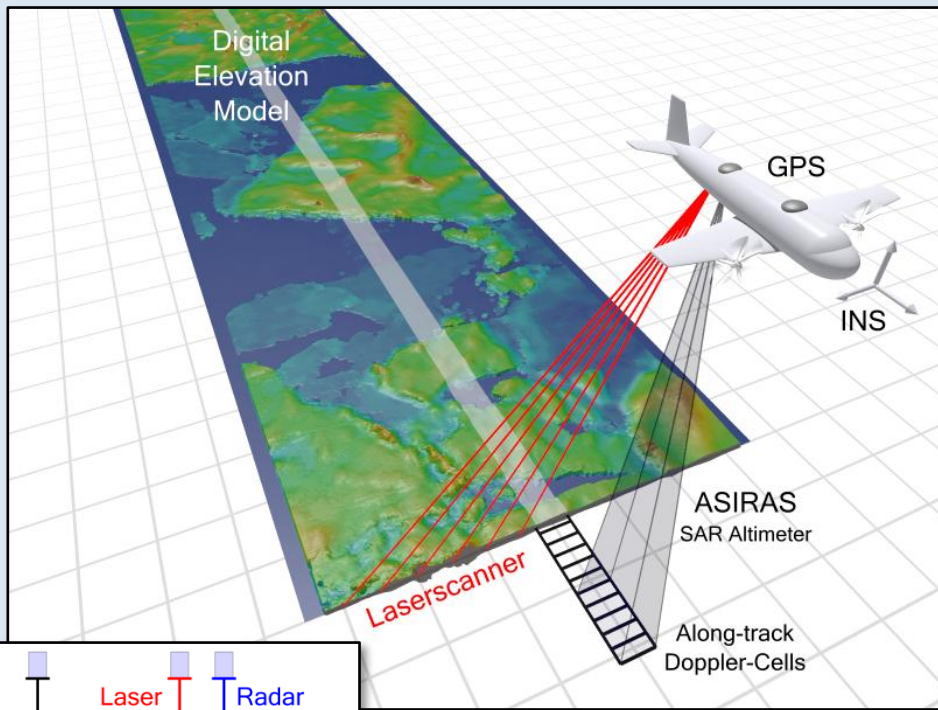
- Sea ice thickness
- Laser/radar altimetry



CryoSat-2 Sea Ice Thickness

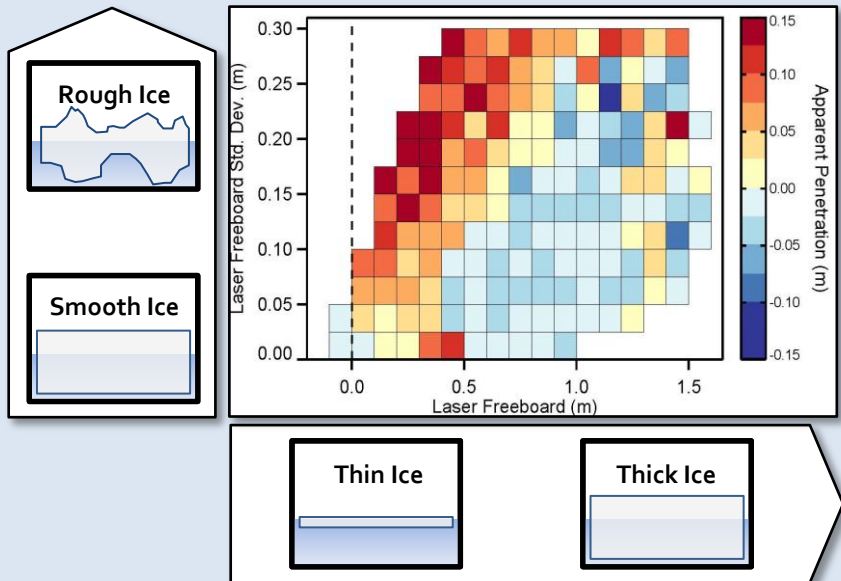
- Ku-Band radar penetration into snow
- Impact of surface roughness and type on radar altimetry
- Freeboard / Thickness ratio

Airborne Laser & Radar Altimetry



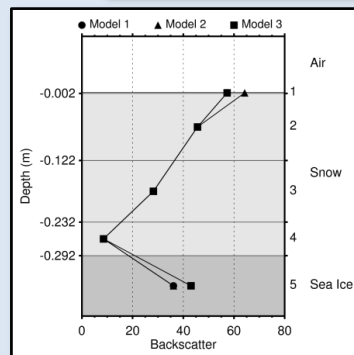
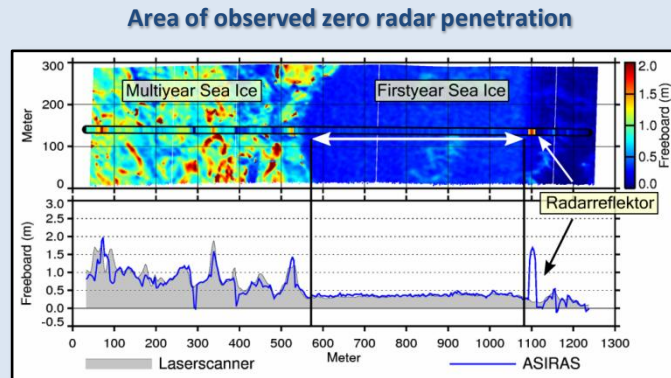
Influence of Surface Type on Radar Range

Airborne Data: Statistical Analysis



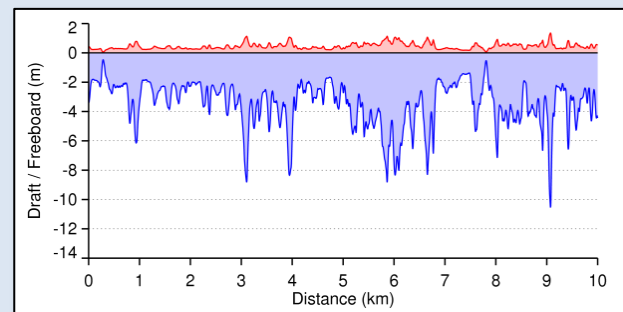
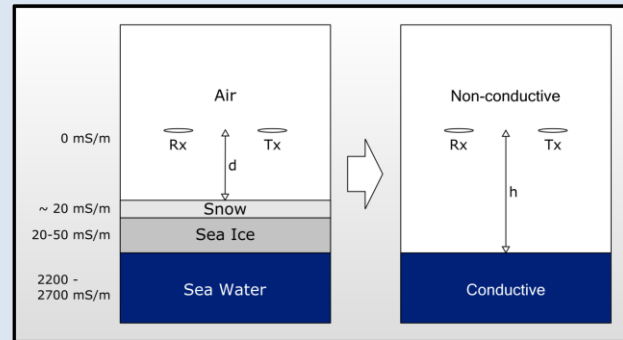
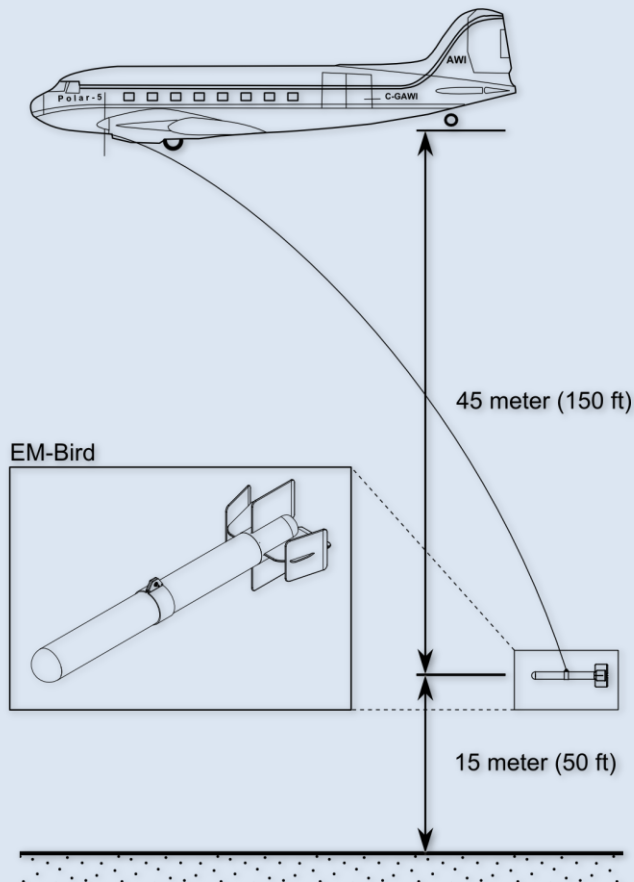
Apparent Penetration: Difference of laser- and radar-freeboard without correction for slower wave propagation speed in snow

In-Situ Data: Case Study



Modelling Study based on snow pit data shows high backscatter surface layer

Airborne EM Sea Ice Thickness Retrieval



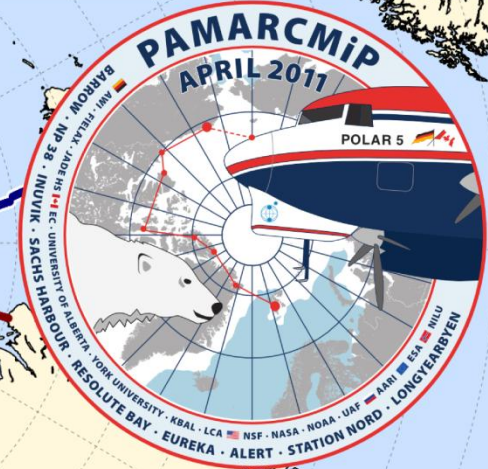
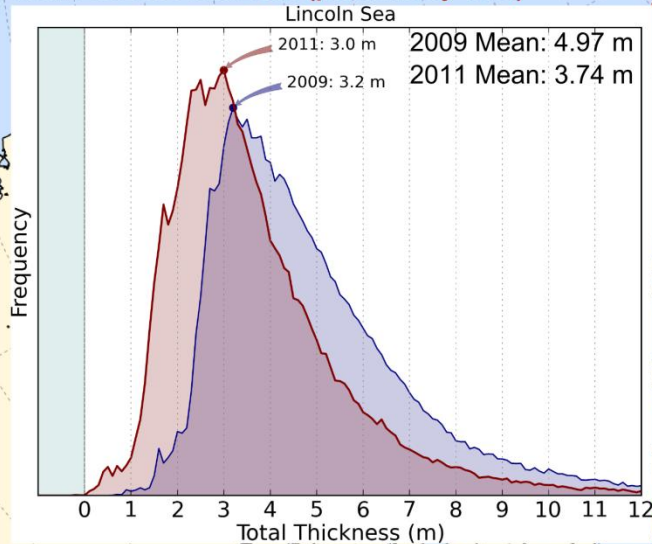
CryoSat-2 Validation Campaign April 2011

Airborne EM Sea Ice Thickness

PAMARCMIP 2009

PAMARCMIP 2011

Change of sea ice thickness distribution (ice + snow)
between 2009 and 2011 (preliminary data)



CryoVEx 2011

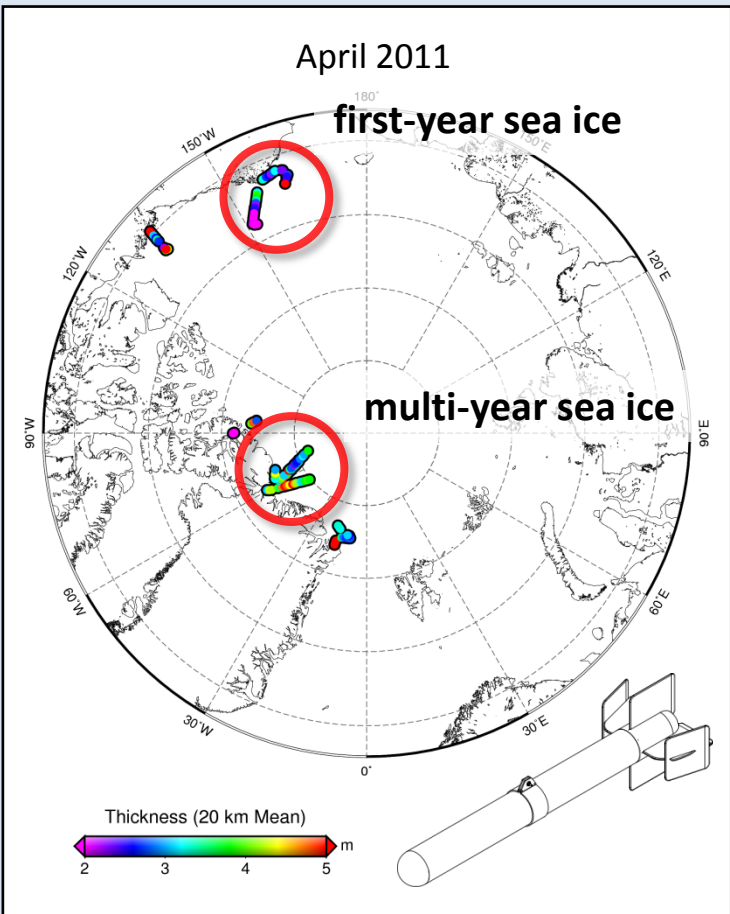
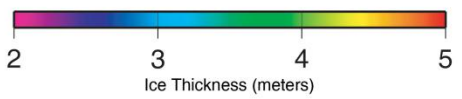
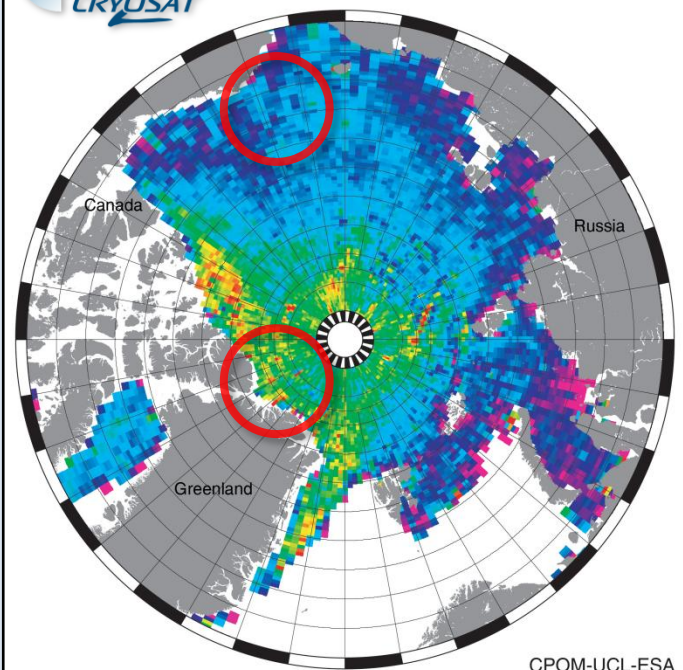
CryoSat-2 Orbit 4400
CryoSat-2 Orbit 4435
CryoSat-2 Orbit 4464



CryoSat-2: First results



Sea ice thickness in the Arctic ocean
(January/February 2011)



First-year sea ice

- Comparable mean sea ice thickness (AEM: 2.5 m)
- Deformation zone close to coast and thin first-year ice further offshore
- Overestimation of first-year ice thickness by CryoSat-2?

Multi-year sea ice

- Comparable mean sea ice thickness (AEM: 4.0 m)
- Significant spatial ice thickness variability in AEM data

Validation Activities

- Successful implementation of ground and airborne field campaigns over **sea ice in the Lincoln Sea in 2006, 2008 and 2011**
- Comparison of laser and Ku-Band radar altimetry **shows that radar penetration into snow is limited and regionally dependent**
- Interpretation of airborne radar signal depends on surface roughness
- AEM sea ice thickness provides useful and large-scale validation data

CryoSat-2 First Results

- First Arctic sea ice thickness map available (January-February 2011)
- Multi-year ice zone well represented in **mean thickness and spatial extent**
- Mean thickness of first-year ice higher than in AEM data in Beaufort/Chukchi Sea
- CryoSat-2 product will improve due to ongoing validation activities and longer data collection period